An Improved Elevator for Deep Bin Potato Storages

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PREFACE

This report is based upon research conducted at the Red River Valley Potato Research Center, East Grand Forks, Minn., and is part of a larger research project covering the development of more efficient work methods, equipment, and facilities for off-farm handling, sorting, cleaning, grading, sizing, and packing late crop potatoes. The report describes a space-saving potato elevator which was developed, built, and tested at the Research Center. The research which is the basis for this report was conducted by the Marketing Research Division, Agricultural Marketing Service, in cooperation with the Agricultural Engineering Research Branch, Farm and Land Management Research, Agricultural Research Service. This report is one of a number of interim reports issued to make available to industry groups some of the results of the research prior to the publication of final reports.

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SUMMARY

The present trend is to wash more of the table stock potatoes and package them for sale to consumers. Potato packers are finding it necessary to shift from small portable equipment to stationary washing and packing lines. In 2-floor plants some method must be employed to move the potatoes from the lower floor to the upper floor where the stationary packing lines are usually located.

In order to improve the movement of potatoes between floors in these plants, research was conducted at the Red River Valley Potato Research Center. As a result of this research, an improved bucket-type elevator was designed, developed, and adapted for handling potatoes. The first full scale prototype was built and tested during the 1953-54 packing season. Although these tests were quite successful, the original elevator was modified to include: (1) A more durable bucket chain, (2) a simpler bucket attachment, (3) a draper chain feed, (4) full-height rising chain guides, and (5) a slower speed range.

During the 1954-55 season this modified elevator was tested again with better results than the previous season. A number of successful installations have been made of this elevator in commercial potato storage and packing houses.

The elevator can be constructed from commercially available parts by a good shop mechanic or custom made at a machine shop. With an allowance for the necessary modifications to adapt the elevator for a specific installation, the cost of this elevator should be about $1,000.

Some of the advantages of the elevator are that: (1) It uses less space than some of the equipment it replaces; (2) it causes little or no injury to the potatoes; and (3) it can be used to regulate the flow of potatoes to the packing line to obtain efficient output of packing line labor and equipment.

AN IMPROVED ELEVATOR FOR DEEP BIN POTATO STORAGES

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BACKGROUND OF THE STUDY

About 80 million bushels of potatoes annually are stored and prepared for market in 2-floor structures having bins that are deep or below ground level. Currently much of this volume is graded and packed by portable grading equipment operated at the bin floor level. However, the trend is to wash table stock potatoes and package them for sale to consumers. As a result, small portable equipment for packing potatoes directly from the bins is being replaced by large stationary washing and packing lines. This development creates a number of problems, one of which is to provide adequate space for the new equipment.

The upper floors of existing deep bin storages, which often are at car floor or truck bed level, have been found to be the most suitable location for stationary packing lines. This changeover has made it necessary to shift from the elevating of potatoes in bags or other handling methods to elevating of potatoes in bulk from the lower to the upper floor.

Present methods of moving potatoes from the lower floor to the upper level for grading and packing include both the elevating of loose potatoes on inclined conveyors and the forking of loose potatoes into boxes, barrels, bags, or other containers for elevating to the packing line. None of these methods are entirely satisfactory. A conventional inclined conveyor occupies considerable floor space, and extra horizontal conveyors frequently are required. Filling containers from bulk storage means additional handling, which increases labor requirements and damage to the potatoes.

For these reasons improved method and equipment for moving loose potatoes between floors was needed. The object of the research conducted at the Potato Research Center was to develop equipment which would replace the long sloping elevating conveyors used in 2-level facilities and do the job more efficiently. It was also necessary that such equipment fit in with present methods of moving potatoes horizontally and that it deliver potatoes to washing and packing lines with a minimum amount of injury. In addition, it needed to have adequate capacity so that it would not "bottleneck" the packing line. To meet these requirements, a version of a bucket-type elevator was developed.

After first building and testing a small scale experimental model, a prototype bucket elevator was built and installed in the storage facilities at the Red River Valley Potato Research Center. Tests of the elevator showed that, in addition to meeting the needs for space-saving equipment with adequate capacity and rate of flow, it handled the potatoes with little mechanical injury and used less power than conventional types of elevating conveyors. No direct labor is involved in using either the elevator or conveyor to move potatoes between floors.

Since the prototype was built, a number of changes have been incorporated, and it is anticipated that further improvements will be made.

A number of these elevators have been constructed and installed in commercial storage and packing plants in the Red River Valley area. Each of these installations required modification to fit existing facilities. Some of these modifications are discussed in this report. These elevators were adopted commercially during the 1954-55 and 1955-56 packing seasons and have satisfactorily performed the operation for which they were designed.

DESCRIPTION OF POTATO ELEVATOR

This improved potato elevator is essentially a modified bucket elevator. It is designed to move loose potatoes from one level to another; it is most suitable for moving potatoes out of deep or below-grade bins and elevating them to stationary washing and packing lines on an upper floor.

The elevator consists of two endless motor-driven chains running parallel to each other. Especially designed buckets are attached between the chains. A variable speed drive is used to move the chains and buckets around three sets of twin sprockets mounted on solid shafts in the head assembly and one set of twin sprockets in the foot assembly.

A modified hopper is used to feed the potatoes into the buckets. The buckets are of open design to carry the potatoes but not water or small objects. The entire elevator is supported in an open frame of angle iron. The chains carrying the buckets travel through guides on the elevating side. These guides steady the loaded buckets so that the potatoes will not fall out and be injured.

This elevator can be used in combination with either conveyors or flumes to move potatoes horizontally from deep bin storages and then vertically to the washing and packing line. Potatoes are fed into the elevator buckets and elevated to the upper floor level. At the upper level, the three sets of sprockets in the head assembly are designed to tip the buckets 90° from a horizontal position as they pass over one set of sprockets. As each bucket is tipped, the potatoes spill out gently onto a belt conveyor which moves them to the washer. The empty buckets are then carried around a second set of sprockets, over the third set, and begin their downward travel to be refilled.

The elevator can be operated at different rates of speed to deliver different volumes of potatoes per hour to the packing line.

An innovation of this elevator is that the buckets are emptied on the way up rather than on the way down, which is the usual bucket elevator method of discharge. This method of emptying the flights, that is, tipping and permitting the potatoes to spill out rather than dumping and causing the potatoes to fall out, was devised to minimize the bruising and other injury which might be inflicted on the potatoes.

ELEVATOR PERFORMANCE

The prototype bucket elevator was installed at the Red River Valley Potato Research Center during the 1953-54 packing season. This elevator was used to move 30,000 bushels of potatoes, stored in deep bins, from the lower floor to the packing room on the upper floor. The elevator was modifed and used again during the 1954-55 and 1955-56 seasons. In addition to the results obtained from tests at the Center, some results were obtained in commercial storage and packinghouses which installed this type of elevator during the 1954-55 and 1955-56 seasons.

Operating Speeds

The operating speed of the elevator, and the consequent volume of potatoes delivered to the washers, can be varied to meet the requirements of the packing line. This variable speed is a necessary feature because the average quality and size of potatoes vary greatly from lot to lot, and if quality is poor, the potatoes must be delivered to the washing and packing line at a slower rate to permit proper sorting by the packing line crew. If quality is good, the potatoes may be delivered to the line at a faster rate in order to provide enough potatoes to fully utilize the time of the packing line workers. When small containers are being packed, bagging capacity then becomes the pace-setting operation, and care must be taken not to operate the packing line so fast that too many potatoes accumulate at the bagging end.

Operating speeds of the prototype elevator at the Center ranged from 50 to 80 feet per minute (hereafter referred to as f. p. m.) in 1953-54 and 30 to 50 f. p. m. in 1954-55 and 1955-56. At some commercial installations it might be desirable to have a greater range in operating speeds. The elevator operates satisfactorily at speeds of 30 to 90 f. p. m. However, the higher speeds result in unnecessary wear on the equipment and are not recommended unless greater capacity is required. Moreover, speeds above 90 f. p. m. are not recommended because: (1) Wider bucket spacing would be needed to insure their filling; (2) shock injury may occur at receiving end; (3) potatoes may be vibrated out of buckets; and (4) excessive throw may occur at delivery end.

Handling Capacity

The capacity of the elevator depends upon the width of the elevator, the size of the bucket, the spacing, and the speed plus uniformity of bucket filling. Bucket loads vary with potato size. When operated at a speed of 40 f. p. m., an elevator 30 inches wide, with buckets spaced approximately 9-1/4 inches apart (every fourth link of No. 77 combination chain, 2.308-inch pitch), will deliver 52 buckets of potatoes to the line per minute. At a speed of 90 f. p. m., 117 buckets are delivered per minute. Each bucket holds between 3 and 5 pounds of potatoes, depending on size, range in size, and shape of potatoes. Therefore, when uniformly fed to full capacity and when operating within this 40 to 90 f. p. m. speed range, the elevator delivers from 156 to 585 pounds of potatoes a minute.

Table 1 shows the quantity of potatoes the elevator will deliver at different operating speeds when the buckets are filled to different weights. By use of this table an experienced warehouse operator should be able to regulate the elevator speed so that potatoes will be delivered to the packing line at a rate which will keep the crew fully occupied and working at a pace permitting optimum grading and packing efficiency.

The bucket elevator tested at the Research Center has a "bin-run" rate of delivery of 9,000 to 30,000 pounds an hour. As the net amount of graded and packed potatoes varies from 60 to 90 percent of the bin-run weight, the "graded out-put" rate of delivery will range from roughly 1 to 6 carloads (400 100-pound bags each) per day. This difference is based on bin-run potatoes which include under and over sizes and other unmarketable potatoes, in addition to marketable ones and an allowance for interruptions in line operation. Table 2 shows a comparison of gross elevating rate per minute, per hour, and per day. Tables 1 and 2 are included so that the warehouseman selecting equipment can get a better idea of the operating range to be expected.

Table 1.--Quantities of potatoes delivered to packing line per minute by an elevator 3 feet wide, with specified sizes of bucket loads and different operating speeds[1]

Operating speed (f. p. m.)	Quantity of potatoes delivered to the packing line per minute when there are--		
	3 pounds per bucket	4 pounds per bucket	5 pounds per bucket
	Pounds	*Pounds*	*Pounds*
40	156	208	260
50	194	260	324
60	234	312	390
70	272	362	454
80	312	414	518
90	351	468	585

[1] Based on a bucket spacing of approximately 9-1/4 inches, which is a bucket to every fourth link of No. 77 combination chain.

Table 2.--Quantities of "bin-run" potatoes delivered to the packing line per day by an elevator 3 feet wide when specified quantities are delivered per minute

Elevator delivery rate per minute (Pounds)	Carloads of bin-run potatoes delivered to the line per day[1]		
	Gross carloads[2]	Net carloads	
		60% outturn	90% outturn
	Number	*Number*	*Number*
156..................	1.9	1.1	1.7
260..................	3.1	1.9	2.8
362..................	4.3	2.6	3.9
468..................	5.6	3.4	5.1
518..................	6.2	3.7	5.6
585..................	7.0	4.2	6.3

[1] Eight-hour day of continuous operation.
[2] Gross carloads of 40,000 pounds each of bin-run potatoes.

Methods of Feeding the Elevator

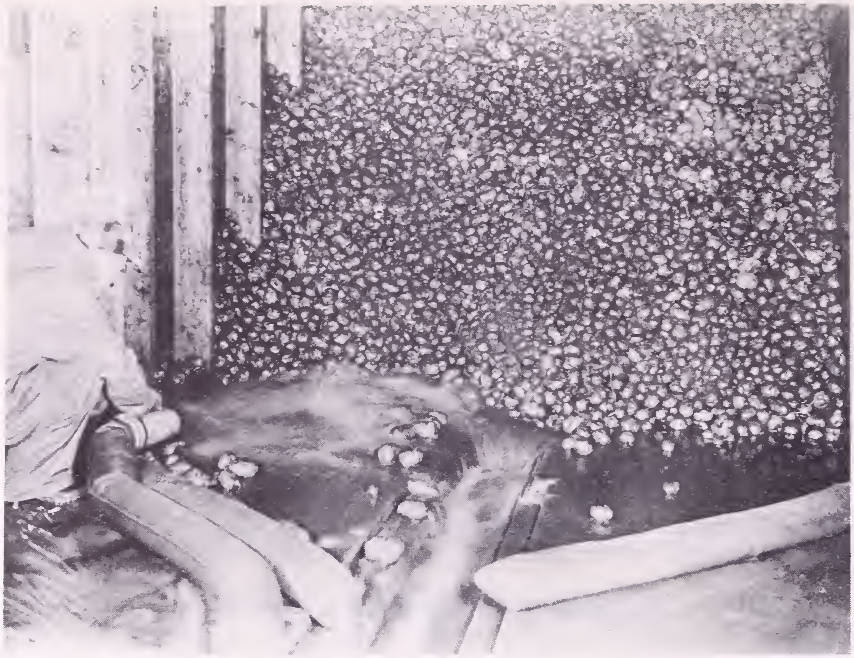
The performance and capacity of the elevator and the resulting efficiency of the packing line operation depend on the uniformity of the flow of potatoes from the bins to the elevator. The present methods of moving potatoes from the bins to the elevator consist of the following combinations of equipment: (1) Flume to small hopper, either submerged or nonsubmerged; (2) flume to large submerged hopper; (3) flume to nonsubmerged draper chain conveyor; and (4) a series of dry belt conveyors.

The shift from portable to stationary packing lines, which brought about the need for adapting the bucket-type elevator for handling bulk potatoes, also brought about the need or opportunity to adopt fluming. Potatoes that will be washed before they are sorted, sized, and packed, are now being moved in flumes in 300 to 600 gallons of water per minute at rates of 10,000 to 60,000 pounds per hour for distances of 20 to 800 feet. Flumes are used between trucks, cars, or bins and elevators and the packing line. Although conveyors are still being used for moving dry potatoes to elevators, they require more labor for handling the equipment and for removing dirt from the bins than flumes require.

When bins are emptied either by flume or by conveyor, potato roll-down normally maintains an angle of repose of 7 vertical to 10 horizontal. However, because of sprouting, excessive shrink, dirt or trash, the face of the pile may alternately hold at a much steeper angle, then give way in an avalanche of potatoes. This cycle may starve, then slug the elevator and packing line in spite of the best efforts of the worker in the bin (fig. 1) unless a positive regulator is placed in the line between the flume or conveyor and the elevator.

Flumes and Small Hopper Feeder

The small hopper is one of the less effective elevator feed regulators (fig. 2). Because it has a relatively small holding capacity, this size of hopper underfeeds the elevator immediately after underfeeding of flumes at bin. Moreover, because of its overloading tendency, this hopper overfeeds the elevator after overfeeding at bin. But, because it is portable, it has been used by some houses for feeding potatoes at 2 or more levels.



Neg. BN-2515

Figure 1. --Washing potatoes into a flume--the worker can assist in regulating the flow of potatoes to the elevator, but occasionally potatoes hold up for a while in steep slopes then give away in an avalanche, resulting in an uneven flow to the elevator.

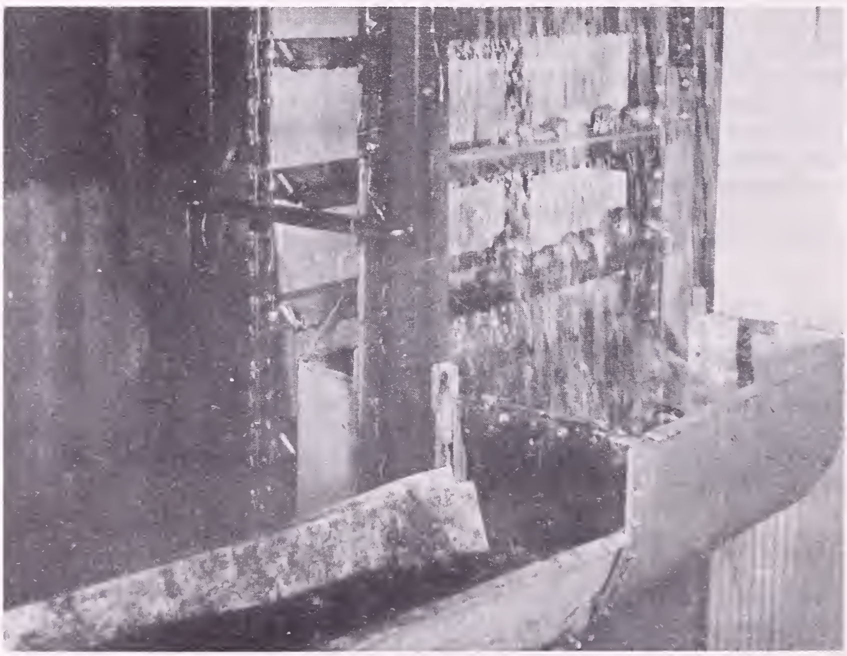


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Figure 2. --The small hopper is one of the less effective elevator feed regulators.

Flumes and Large Hopper Feeder

The large hopper is one of the more effective elevator feed regulators (fig. 3). Having a relatively large holding capacity, it seldom underfeeds the elevator following underfeeding at bin. However, the large hopper tends to overfeed the elevator following overfeeding of flumes at the bin after the hopper is nearly full. When it is necessary to locate the elevator at the end of a short flume run, the large hopper is probably the best feeder.

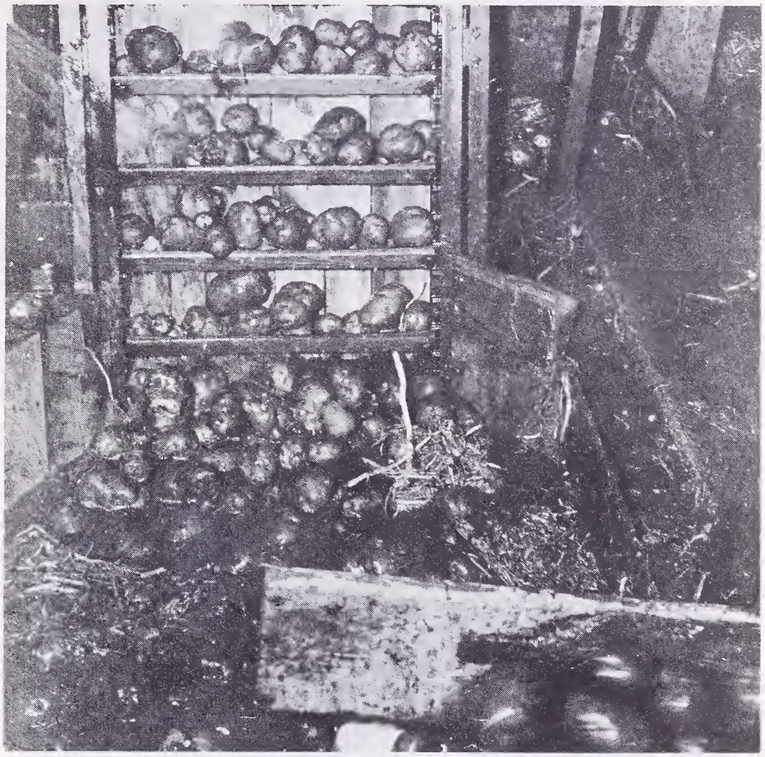

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Figure 3. --The large hopper is one of the more effective elevator feed regulators.

Flumes and Draper Chain Feeder

The inclined draper chain is the most effective feed regulator (fig. 4) for the elevator. By taking advantage of the large holding capacity of the flume, the elevator is seldom underfed following momentary underfeeding at bin. As the draper chain is sloped to take only a single layer of potatoes and is geared to the elevator, it seldom overfeeds the elevator even with momentary overfeeding at the bin.

Dry Horizontal Belt Feeder

The dry horizontal belt feeder is the least efficient elevator feed regulator (fig. 5). Having but a relatively small holding capacity, it underfeeds the elevator following underfeeding of connecting conveyors at the bin. Moreover, as horizontal belt conveyors take a multiple layer of potatoes, they overfeed following overfeeding at the bins. Although

this conveyor usually spreads the potatoes the full width of the buckets, the efficiency of this system depends entirely upon feed regulation at the bin.

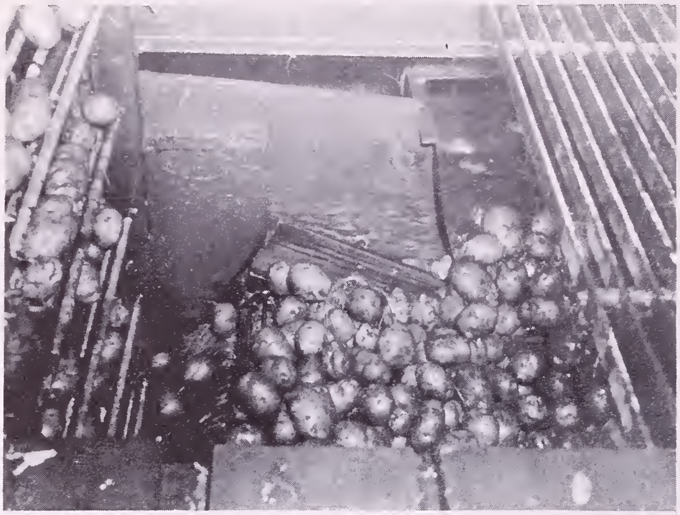

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Figure 4. --The inclined draper chain is the most effective elevator feed regulator.

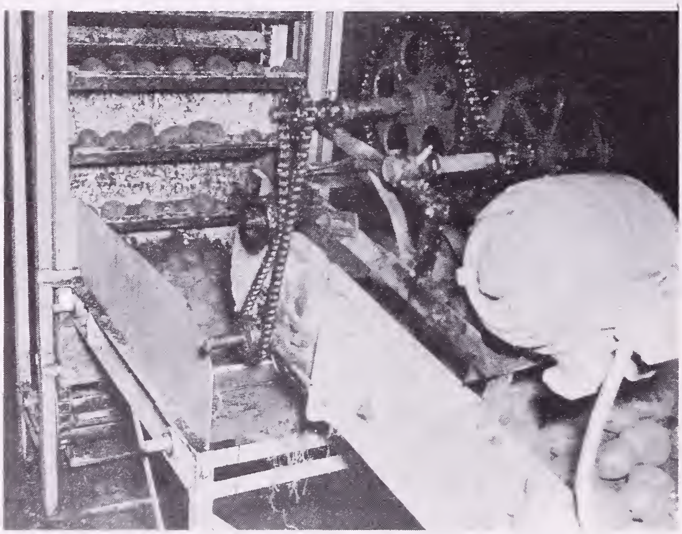

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Figure 5. --The horizontal belt conveyor is the least effective elevator feed regulator.

Mechanical Injury of Potatoes

A bruising test was conducted to determine the amount of injury caused by the bucket elevator used in conjunction with the draper chain conveyor. Irish Cobbler potatoes were used in the test. These potatoes had been stored about 6 months in a commercial storage held at approximately 40°F. and 70 percent relative humidity. In the test, 650 pounds of Irish Cobblers were placed, a few at a time, among Red Pontiacs moving on the draper chain feed conveyor. After being elevated 20 feet, the potatoes were first delivered to a

1-7/8-inch mesh sizing screen and then onto a roller sorting conveyor where the test potatoes were recovered.

The potatoes were checked for new bruises after 24 hours of storage at about 50°F. and 30 percent relative humidity. On examination, 24 hours after they were handled, all test potatoes were of U. S. No. 1 grade and only 0.3 percent were bruised enough to restrict them from U. S. Fancy grade. These results indicate that this equipment caused no damage of commercial significance.

CONSTRUCTION DETAILS OF POTATO ELEVATOR

Among the reasons for developing the bucket-type elevator for handling potatoes were: (1) To save space, and (2) to reduce equipment costs. The prototype elevator at the Research Center occupies the flume pump space for feeding at the lower level and about 8 square feet on the upper level. It is a single unit 20 feet high and is operated by a 1.5 hp. motor. The cost of constructing this elevator was approximately two-thirds the total cost of the 2 elevating and 1 transfer conveyors that it replaced.

Figure 6 shows a section of the elevator after it was remodeled in 1955. Changes included: (1) The use of No. 77 combination chain instead of No. 67 pressed steel chain; (2) loaded bucket guides; (3) a slower speed range; and (4) a movable draper chain feeder replacing the small hopper feeder.

The No. 77 combination chain was substituted for the No. 67 pressed steel chain to provide longer chain life and quieter operation. The No. 67 stamped steel chain was noisy at the reverse bend over the bucket tipping guide. Full height loaded bucket guides were substituted for the shorter guides to hold the buckets steady for the full distance of the lift. This change overcame some objectionable vibrations experienced with the 1953 model. Changes were made in the speed reducer to provide a lower range of bucket speed of 30 to 50 feet per minute (fig. 7) because lower handling rates sometimes are needed at the Research Center for experimental purposes.

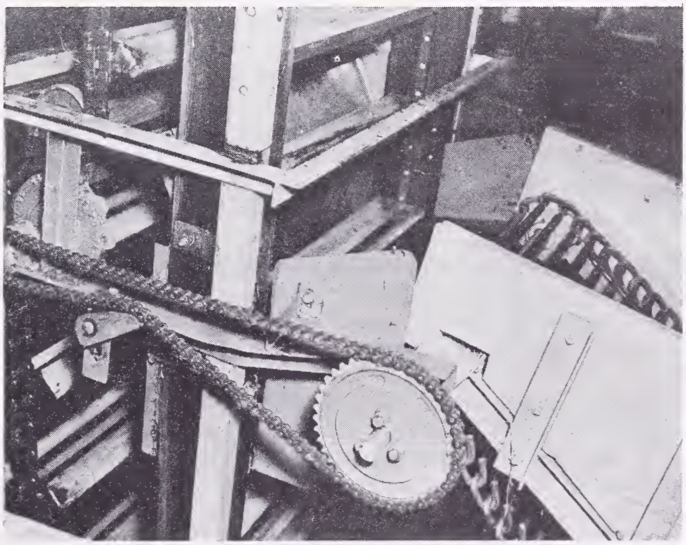

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Figure 6. --The lower end of the 1955 model of the Potato Research Center elevator. Note the draper chain feeder, feeder drive from the elevator chain, and the chain guides.

The draper chain feeder was developed for commercial elevator installations made in 1954. Tests of this feeder demonstrated its superiority over other feeders for stabilizing handling rates. It almost eliminates the overfilling of buckets, prevalent in the 1953

model, which causes severe injuries. The more even handling rate also contributes to higher labor efficiency in hand sorting and other operations of the packing line crew.

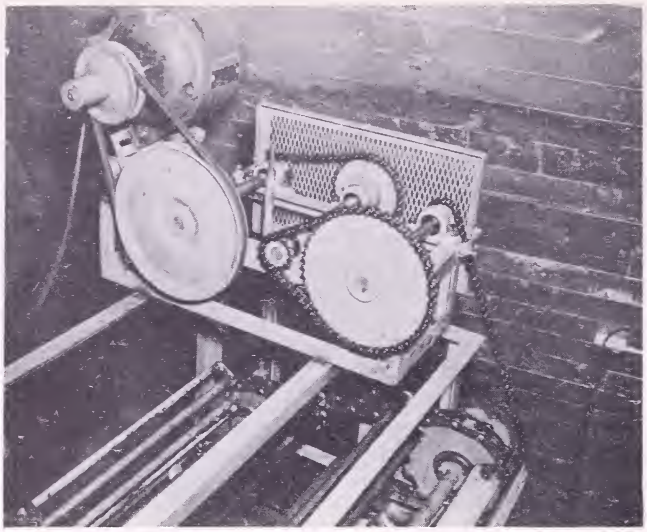

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Figure 7.--The variable speed drive of the elevator at the Potato Research Center, gives a bucket speed range of 30 to 50 feet per minute. Here a 1.5 hp. motor unit is used. The packing line circuit is controlled by a master switch, and each motor is controlled by an individual overload switch.

Design Details

Figure 8 shows the details of an assembled elevator which is 30 inches wide and 20 feet high. It will be noted that in the drawing the elevator parts are numbered. The frame details, including dimensions, are shown in figures 9 and 10.

The 93-inch upper frame section and the 72-inch lower frame section are joined by four 2- by 1-1/2- by 3/16-inch angle iron extensions of a length to suit the storage. These extensions can be drilled as shown in figure 11 so that adjustment can be made to the nearest inch in height to fit the vertical distance between the sump and the packing line.

Details of the draper-chain flow regulating feeder are shown in figure 9. The draper chain feeder is driven directly by the elevator chain and will move potatoes at a rate the elevator can handle. The drive is taken from the return flight of the elevator, so the drive does not interfere with the smooth operation of the rising buckets.

Two types of elevator buckets were tested: The 3/4- by 2-1/2- by 30-inch wood slat buckets, and the 1/2-inch thin-wall conduit buckets. Details of these buckets are shown in figure 12. Although wood slat buckets with end brackets cost about half as much as conduit buckets and appear to be the most practical, commercial builders prefer the conduit type. The pierced end brackets of wood buckets slide over the steel side bars of the No. 77 combination chain without welding. However, commercial builders weld bucket to the steel side bars. Shaft sizes and details are show in figure 13. Note the placing of keyway and machining to fit common sprocket and idler sizes.

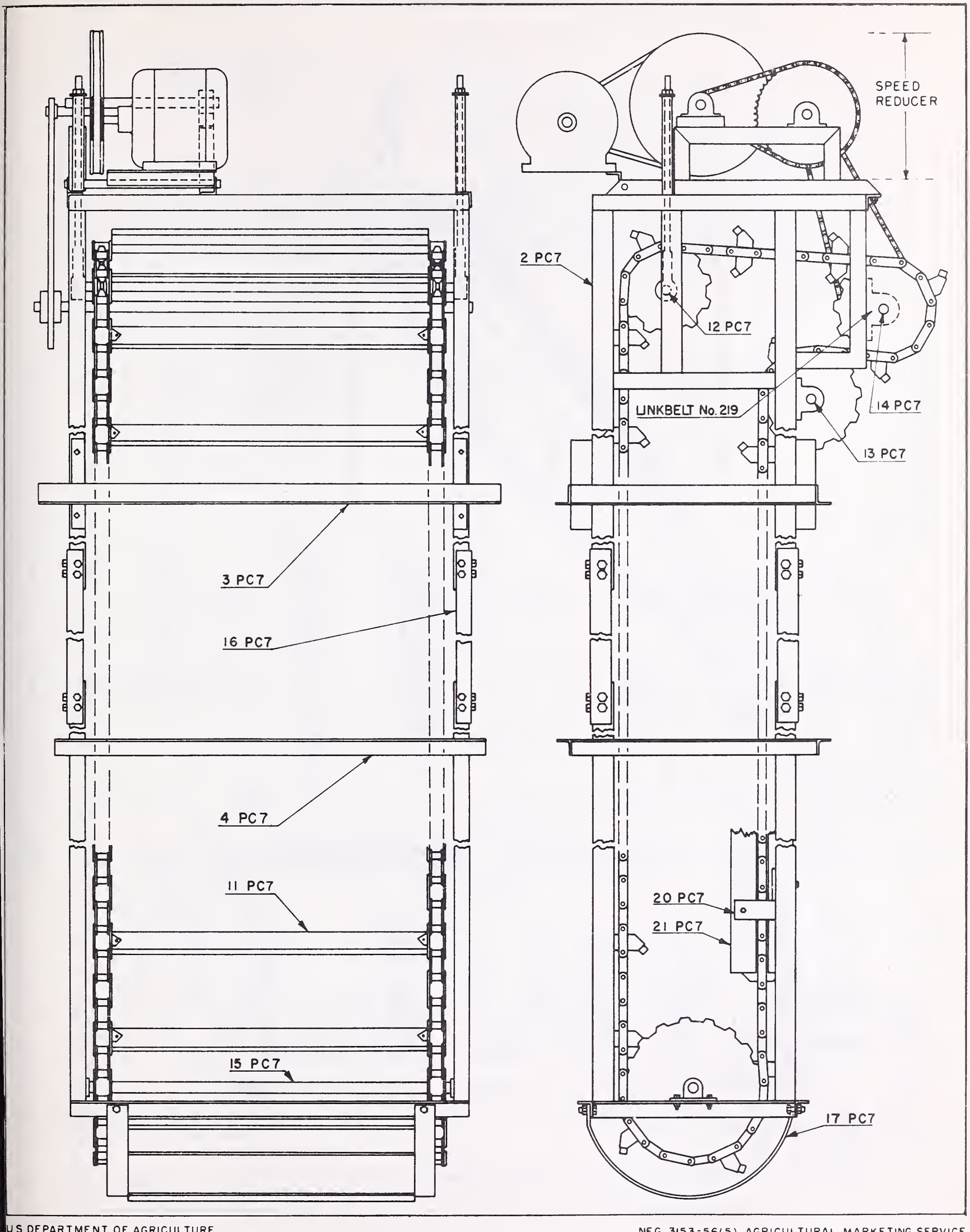

Figure 8. --Front and side elevation of the USDA elevator for potatoes. General layout and parts are numbered for reference to details shown in figures 9 and 10.

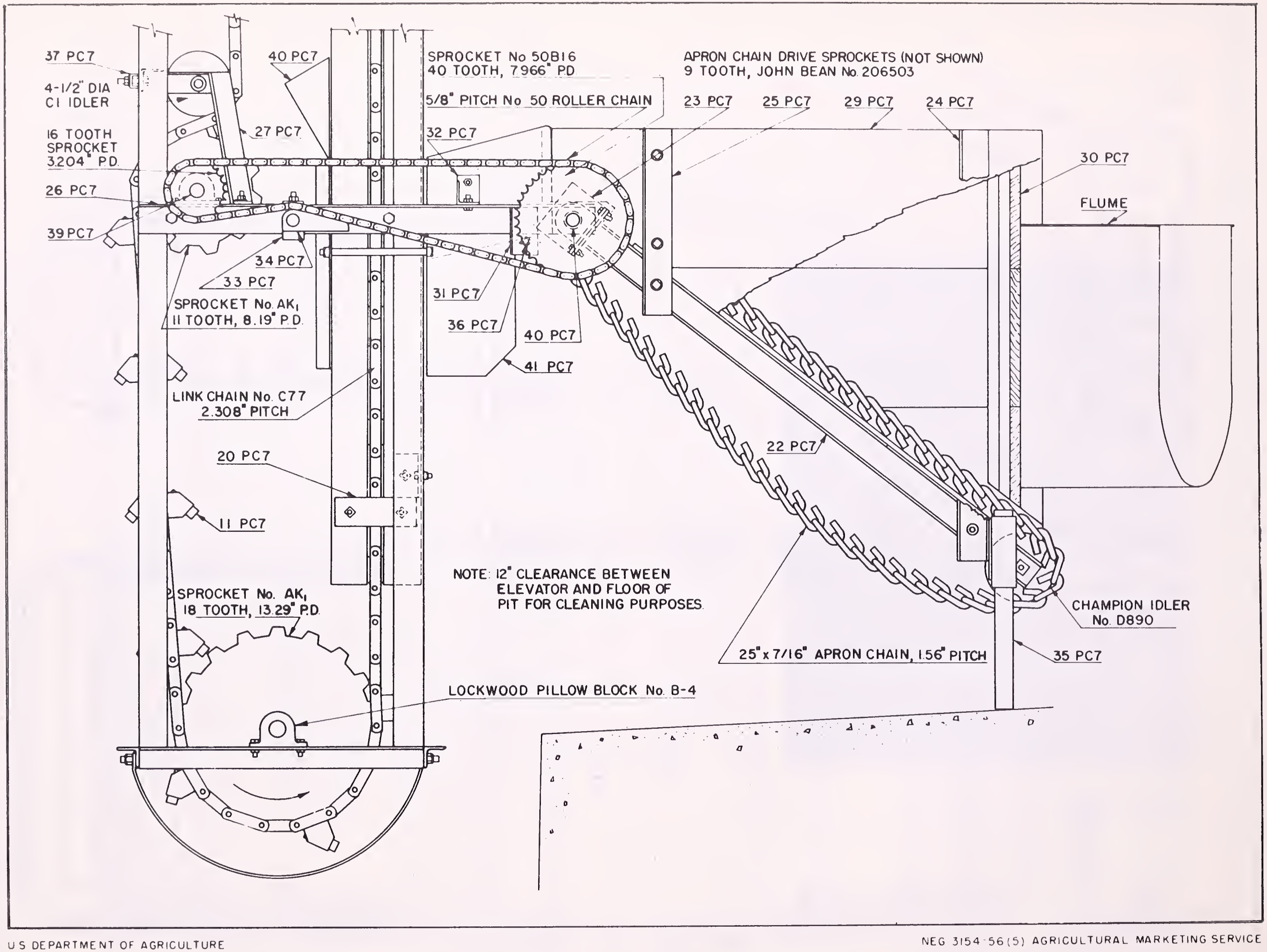

Figure 9. --Details of lower part of elevator frame and feeder assembly.

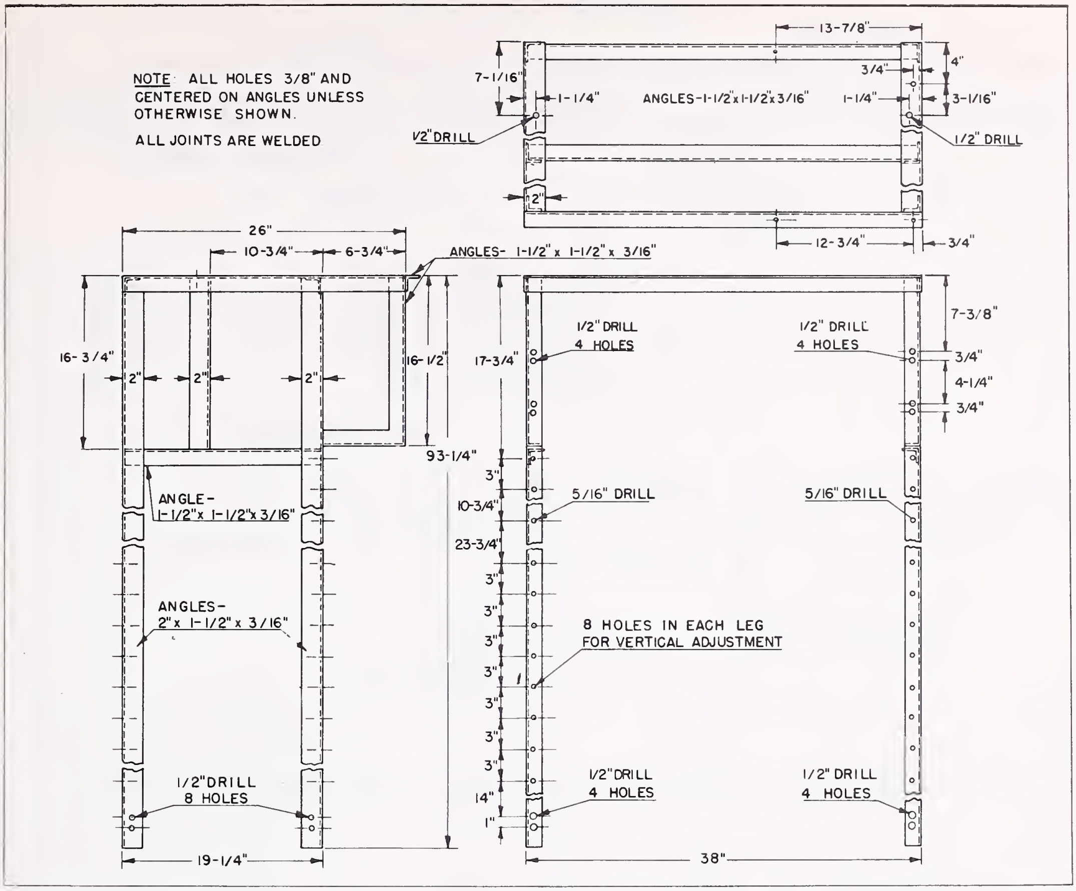

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Figure 10. --Details of upper part of elevator frame.

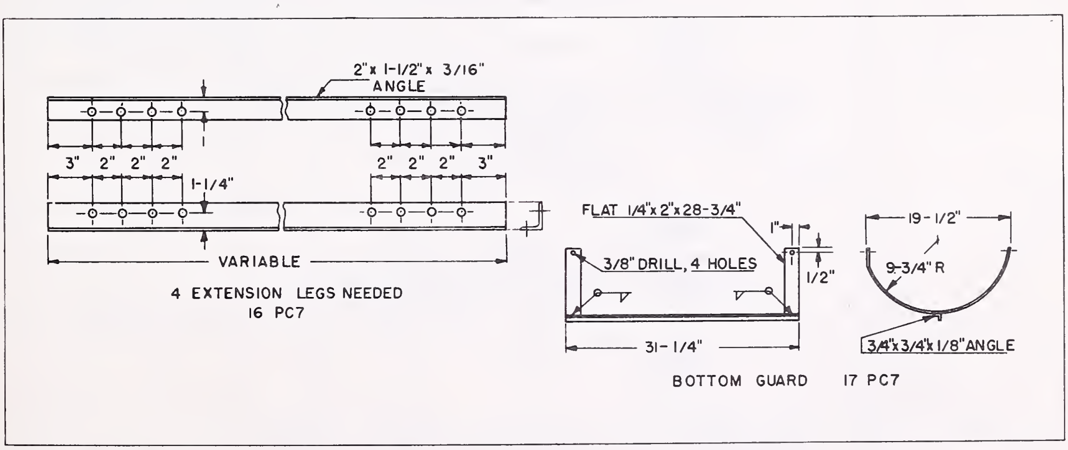

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Figure 11. --Sections for joining the upper and lower elevator framing units and bottom guard detail.

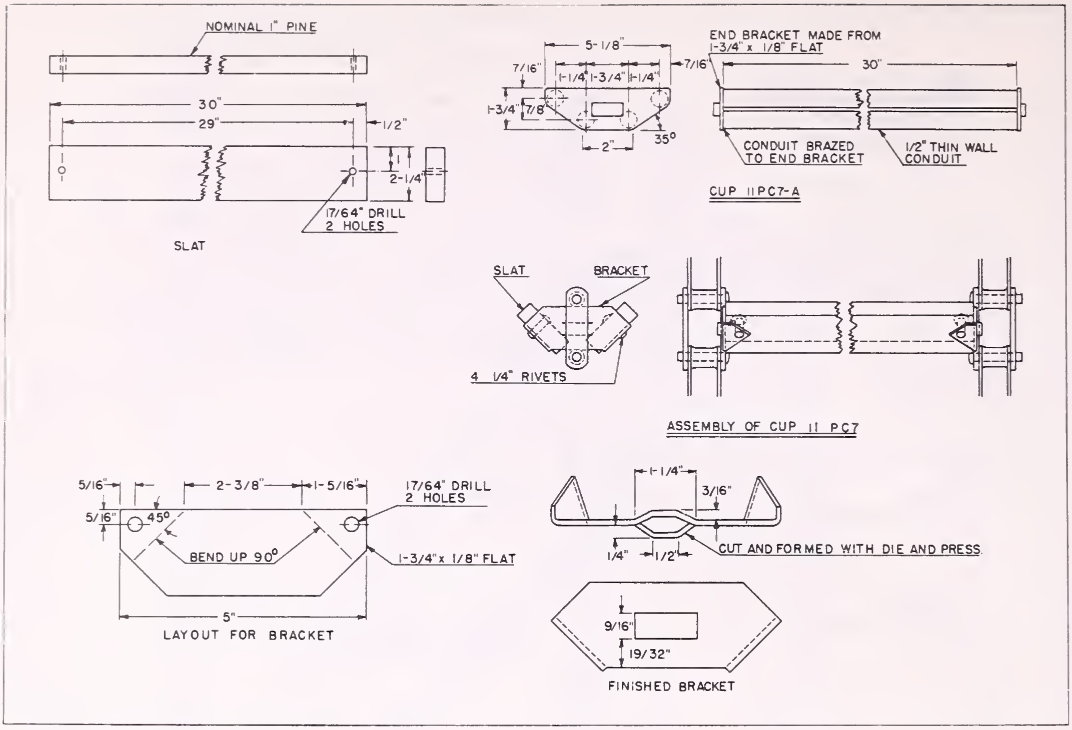

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Figure 12. --Details of elevator buckets--the lightweight wood type and the heavier metal pipe type.

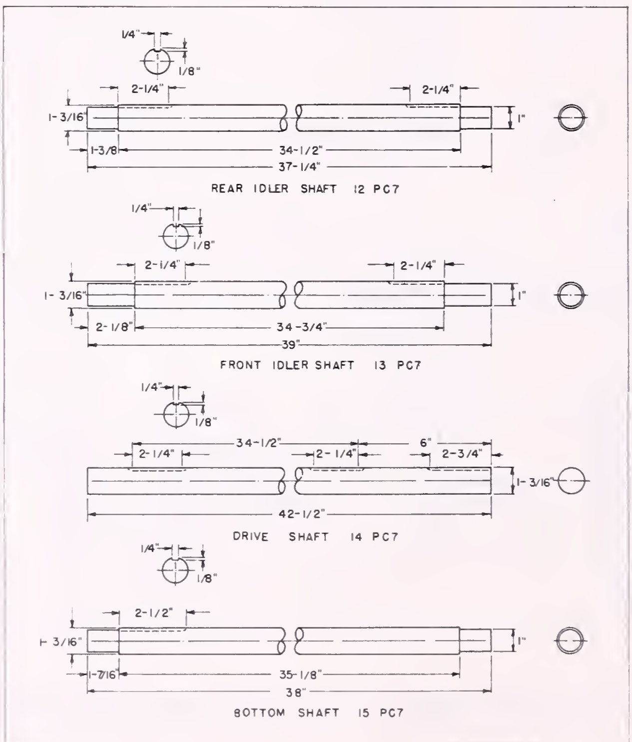

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Figure 13. --Elevator shaft details--sizes and keyways.

Construction Materials

Table 3 contains a bill of materials including bearings, sprockets, and other parts for assembly as shown in figure 8. The bucket guides are detailed in figure 14. These wood guides are of oak and when carefully adjusted should prevent excessive vibration of the rising flight of buckets.

Table 3.--Bill of materials for potato elevator

Steel Stock

Item number	Type of steel stock	Dimensions	Length		Total weight	Part numbers on drawings
			Feet	Inches		
		Inches	*Feet*	*Inches*	*Pounds*	
1....	Angles, bar sizes.....	3/4 x 3/4 x 1/8	2	8	1.6	17
2....	Angles, bar sizes.....	1 x 1 x 1/8	5	4	4.3	40
3....	Angles, bar sizes.....	1-1/4 x 1-1/4 x 1/8	14	10	16.5	1, 4, 22
4....	Angles, bar sizes.....	1-1/2 x 1-1/2 x 1/8	1	7	2.0	22, 32
5....	Angles, bar sizes.....	1-1/2 x 1-1/2 x 3/16	50	0	90.0	1,2,22,27,28
6....	Angles, bar sizes.....	2 x 1-1/4 x 3/16	7	2	14.1	24, 25
7....	Angles, bar sizes.....	2 x 1-1/2 x 3/16	118	10	252.0	1,2,3,16,20
8....	Angles, bar sizes.....	2 x 2 x 1/8	5	7	9.2	26, 33
9....	Structural angles.....	3 x 2 x 3/16	0	9	2.3	23
10....	Channel bar sizes.....	1 x 1/2 x 1/8	1	4	1.2	37, 40
11....	Channel bar sizes.....	2 x 1 x 3/16	6	4	14.7	22
12....	Hot rolled strip......	1-1/2 x 1/8	0	5	0.3	32
13....	Hot rolled strip......	1-1/2 x 3/16	0	11	0.9	22, 27
14....	Hot rolled strip......	1-3/4 x 1/8	53	0	40.0	11
15....	Hot rolled strip......	2 x 1/8	0	7	0.5	31
16....	Hot rolled strip......	2 x 3/16	7	2	9.2	20
17....	Hot rolled flats......	1-1/2 x 3/16	1	0	1.3	22, 27
18....	Hot rolled flats......	2 x 1/4	5	0	8.5	17
19....	Drill rod square......	1/4 x 1/4	2	4	0.5	Keys
20....	Hot rolled rounds.....	1/2 diameter	2	10	1.9	36
21....	Cold finished shafting	1 diameter	7	0	18.8	38, 39
22....	Cold finished shafting	1-3/16 diameter	13	2	50.0	12,13,14,15
23....	Black pipe standard...	1 nom. 1.049 I.D.	8	8	14.6	23, 35, 39
24....	Black pipe standard...	1-3/16 nom. 1.38 I.D.	0	11	2.1	22
25....	Galvanized steel sheets.............	24 x 96 16-gage	8	0	42.5	40, 41

Lumber

Item number	Kind of lumber	Size	Lineal feet	Board feet	Pieces		Part numbers on drawing
					Quantity	Size	
		Inches	*Number*	*Number*	*Number*	*Inches*	
1.........	White pine "C"..	1 x 10	116	97	122	1 x 2-1/4 x 30	11
					2	1 x 10 x 62	29
					3	1 x 10 x 26	30
					2	1 x 1-1/2 x 25	30
					4	1 x 1-1/2 x 27.5	29
					2	1 x 1-1/2 x 17	29
2.........	Oak "C".........	2 x 6	40	40	4	2 x 2-1/2 x 120	21
					4	2 x 2-1/2 x 106±	21
					1	2 x 2 x 5	34

Table 3.--Bill of materials for potato elevator--Continued

Sprockets, Idlers, and Bearings

Item number	Description	Quantity	Bore	Teeth	Tooth pitch	Pitch diameter	Chain number	Catalog number	Manufacturer
		Number	*Inches*	*Number*	*Inches*	*Inches*			
1.....	Sprockets......	2	1	11	2.308	8.19	C77	AK1	Link Belt
2.....	Sprockets......	2	1	9	1.56		Draper	206503	John Bean
3.....	Sprockets......	1	1	16	5/8		50		
4.....	Sprockets......	1	1	40	5/8		50		
5.....	Sprockets......	2	1-3/16	11	2.308	8.19	C77	AK1	Link Belt
6.....	Sprockets......	4	1-3/16	12	2.308	8.91	C77	AK1	Link Belt
7.....	Sprockets......	2	1-3/16	18	2.308	13.29	C77	AK1	Link Belt
8.....	Idlers.........	4	1/2			4.5		D890	Champion
9.....	Take up bearing	2	1					T-B5	Lockwood
10.....	Pillow blocks..	8	1					B4	Lockwood
11.....	Pillow blocks..	2	1-3/16					219	Link Belt

Chain

Item number	Description	Quantity of links	Approximate length	Size	Pitch	Catalog number	Manufacturer
		Number	*Feet*	*Inches*	*Inches*		
1......	Draper chain.....	60	8	7/8 x 25	1.56		
2......	Roller chain.....	307	16		0.62	50	
3......	Combination chain	488	94		2.308	C77	Link Belt

Bolts and Rivets

Item number	Description	Quantity	Size
		Number	*Inches*
1..........	Tinners rivets.................	20	1/8 x 1/4
2..........	Truss head rivets..............	500	1/4 x 1
3..........	Carriage bolts and nuts........	16	1/4 x 1-1/2
4..........	Cap screws and nuts............	24	5/16 x 1
5..........	Cap screws and nuts............	4	5/16 x 1-1/2
6..........	Carriage bolts and nuts........	50	3/8 x 2-1/2
7..........	Cap screws and nuts............	16	3/8 x 1
8..........	Cap screws and nuts............	4	3/8 x 1-1/2
9..........	Machine bolts and nuts.........	10	3/8 x 1
10..........	Machine bolts and nuts.........	6	3/8 x 1-1/2
11..........	Machine bolts and nuts.........	1	3/8 x 8
12..........	Machine bolts and nuts.........	4	1/2 x 1
13..........	Machine bolts and nuts.........	2	1/2 x 5
14..........	Cap screws and nuts............	8	1/2 x 1
15..........	Cap screws and nuts............	8	1/2 x 1-1/2

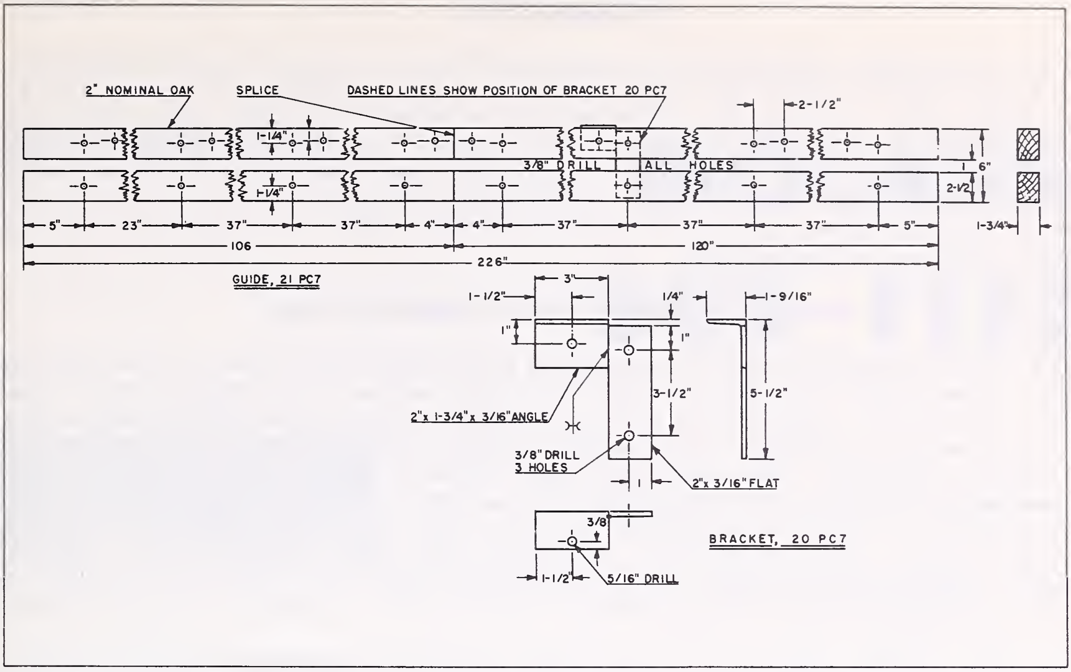

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Figure 14.--Bucket flight guides for the full height reduce vibration of filled buckets.

Details of the speed reducer are not shown because some builders will use gear motors and others will use a built up assembly as shown in figure 7. The major consideration here is the choice of proper sprocket sizes and speeds for elevator speeds of 30 to 90 feet per minute. In many cases a 1 hp. motor will be adequate, but because of the possibility of binding guides or elevator misalignment, adequate power should be provided to handle the load with some misadjustment. The installation includes a spring-controlled straight friction clutch, which is recommended for each installation in order to protect the equipment from damage if foreign material lodges in the mechanism.

Tests indicate that the new elevator has a higher mechanical efficiency than elevating conveyors with inclined flights supported by idlers or slides. However, because of friction in the drive, chains, guides, sprockets, and bearings, the overall efficiency of the elevator may range from 25 to 50 percent. These values allow for misalignment, sliding friction in the guides, and faulty lubrication. Table 4 shows the horsepower of motors required to elevate the potatoes 20 feet for the speed and bucket loadings indicated in table 1.

Table 4.--Power requirements for elevating potatoes 20 feet for various bucket loads and speeds[1]

Bucket speed (f. p. m.)	Size of bucket load		
	3 pounds	4 pounds	5 pounds
	Horsepower	*Horsepower*	*Horsepower*
40	0.5	0.5	0.75
50	.5	.75	1.00
60	.75	.75	1.5
70	.75	1.00	1.5
80	.75	1.00	1.5
90	1.00	1.50	1.5

[1] Power unit is based on overall elevator efficiency of 25 percent to allow for friction in the drive, chains, guides, sprockets, and bearings.

Estimated Cost

The first elevators constructed by commercial firms ranged in cost from $750 to $1,000 for elevators 20 feet high. Although one storage operator built an elevator for less than $750, some commercial jobs have been reported at $1,250. The choice of many items will effect total construction costs. For instance, the No. 77 combination chain will cost 2 to 3 times as much as the No. 67 pressed steel chain. Direct flume feeding will cost $50 to $100 less than a draper-chain feeder. Steel rod buckets made from 3/8-inch pipe or 1/2-inch steel tubing will cost from $300 to $400. Wood buckets will range from $200 to $300 for a 20-foot lift.

CONCLUSIONS AND RECOMMENDATIONS

Three crops of potatoes have been handled at the Research Center by the new type of elevator. Two crops have been handled in storage and packing plants of six cooperating firms, on elevators modeled after the elevator at the Research Center. In each case, performance has been superior to that of the inclined elevating conveyors which the bucket elevators replaced. The small amount of space occupied by the elevator permits a more compact arrangement of equipment. In one plant a whole bin was previously occupied by elevating conveyors; now, less than half of this bin is occupied by the elevator, and more than half is used for storage. In both the Research Center and the cooperating plants power requirement is less. At the Research Center two motors previously were used on the elevating conveyors; one of these motors now is sufficient for the elevator.

Tests show that the efficiency of the bucket elevator is dependent on the type of feeder used. The feeder is required to regulate the flow between flume or conveyor and elevator. Uniform flow to the buckets is necessary so they will be full but not overloaded. A steady flow over the packing line is necessary to insure predictable output and efficient operation.

Adequate space should be provided around the elevator for cleaning the sump at the outlet of fluming system.

In designing an elevator for an existing packing line, or in choosing a new packing line to fit an existing elevator setup, it is advantageous to have the elevator and the packing line the same width to insure an even flow of potatoes between units in the line.

The elevator should be operated at a speed which will feed the packing line at the rate required for most efficient operation. Equipment should be planned to permit adjusting the delivery rate to suit widely different bin-run qualities of different lots of potatoes.

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